WE CLAIM:

1. An exposure system that exposes a substrate with electromagnetic energy from an electromagnetic energy source, said system comprising:

a programmable mask comprising at least one two-dimensional array of structures that, in use, is disposed between the substrate and the electromagnetic energy source, at least some of said structures within said array having an active region comprising a material with a bandgap, the material being changed from transparent to opaque by application of a stimulus; and

a controller coupled to the mask, the controller controlling the stimulus applied to said structures to cause the structures to interact with and selectively modulate, in accordance with a programmable two-dimensional pattern, electromagnetic energy from the source so as to provide a two-dimensional programmable exposure pattern of electromagnetic energy exposing at least part of the substrate.

2. The system of 1 wherein the material with a band gap is chosen from the group consisting of GaN, AlN, sapphire, diamond, SiO2, LiF, ZnS, and ZnSe.

3. The system of claim 1 wherein the material has electrons and holes, and the controller-applied stimulus alters the light attenuation of the structures by changing the density of occupied initial states or the density of unoccupied final states of either the electrons or the holes.

4. The system of claim 1 wherein the controller changes the light attenuation of the structures by changing the conductivity thereof.

5. The system of claim 1 wherein the substrate comprises a semiconductor wafer.

6. A system for exposing a semiconductor wafer with electromagnetic energy from a source, comprising:

a programmable photolithographic mask comprising at least one two-dimensional array of structures disposed between the wafer and the source of electromagnetic energy,

at least some of said structures within said array comprising an active region comprising a material which can be made transparent or opaque by applying a voltage to change the density of occupied initial states or the density of unoccupied final states of either the electrons or the holes; and

a controller coupled to the mask, the controller controlling a voltage applied to said structures to thereby cause the structures to interact with and selectively modulate, in accordance with a programmable two-dimensional pattern, electromagnetic energy from the source so as to provide a two-dimensional programmable exposure pattern of electromagnetic energy for exposing at least part of the wafer.

7. The system of claim 5 wherein the material is chosen from the group comprising GaN, AlN, sapphire, diamond, SiO2, LiF, ZnS, and ZnSe.

8. An exposure system comprising:

a source of electromagnetic energy;

a moveable stage that supports a substrate;

optics that direct said electromagnetic energy from the source toward the stage

a programmable photolithographic mask optically coupled in an optical path between the source and the stage, the mask comprising at least one two-dimensional array of structures, at least some of said structures within said array comprising an active region comprising a material which can be made transparent or opaque by applying a voltage or current to change the density of occupied initial states or the density of unoccupied final states of the electrons; and

an electrical controller coupled to at least some of said structures, said controller applying a controlled voltage or current to said structures thereby causing said structures to interact with and selectively modulate, in accordance with a programmable two-dimensional pattern, electromagnetic energy from the source so as to provide a two-dimensional programmable exposure pattern of electromagnetic energy for exposing at least part of a substrate disposed on the stage.

9. The system of claim 8 wherein the material is chosen from the group comprising GaN, AlN, sapphire, diamond, SiO2, LiF, ZnS, and ZnSe.

10. The system of claim 8 wherein said substrate comprises a semiconductor wafer.

11. A wafer exposure system for exposing a wafer, said system comprising:

a source of electromagnetic energy;

a movable wafer stage that supports and positions said wafer;

a programmable photolithographic mask disposed between the source and the stage, the mask comprising at least one two-dimensional array of structures, at least some of said structures within said array comprising a semiconductor active region having holes comprising a material which can be made transparent or opaque by applying a voltage or current to change the density of occupied initial states or the density of unoccupied final states of the holes; and

a voltage or current source that applies at least one controlled voltage or current to at least some of said structures; and

an electrical controller coupled to the voltage or current source, the controller controlling the voltage or current said voltage or current source applies to said structures to thereby cause the structures to interact with and selectively modulate, in accordance with a programmable two-dimensional pattern, electromagnetic energy from the electromagnetic energy source to provide a two-dimensional programmable exposure pattern of electromagnetic energy exposing at least part of the wafer on the stage.

12. The system of claim 11 wherein the material is chosen from the group comprising GaN, AlN, sapphire, diamond, SiO2, LiF, ZnS, and ZnSe.

13. The wafer exposure system of claim 11 wherein the controller includes a digital processor.

14. A method of exposing a substrate comprising:

placing a programmable photolithographic mask comprising at least one two-dimensional array of structures between the substrate and a source of electromagnetic energy, at least some of said structures within said array including an active region comprising a material whose light attenuation coefficient is changed by applying a voltage or current to change the density of occupied initial states or the density of unoccupied final states; and

controlling a voltage or current applied to said structures to interact with and selectively modulate, in accordance with a programmable two-dimensional pattern, electromagnetic energy from the source to provide a two-dimensional programmable exposure pattern of electromagnetic energy exposing at least part of the substrate.

15. The method of claim 14 wherein the material is chosen from the group comprising GaN, AlN, sapphire, diamond, SiO2, LiF, ZnS, and ZnSe.

16. The method of claim 14 wherein the substrate comprises a wafer.

17. The method of claim 14 wherein the said initial and final states are either electrons or holes.

18. A method of exposing a substrate comprising:

placing a programmable photolithographic mask comprising at least one two-dimensional array of structures between a wafer and a source of electromagnetic energy, at least some of said structures within said array comprising an active region comprising a material whose light attenuation coefficient can be changed from transparent to opaque by applying a voltage or current; and

applying a controlled voltage or current to said structures to cause said structures to interact with and selectively modulate, in accordance with a programmable two-dimensional pattern, electromagnetic energy from the source so as to provide a two-dimensional programmable exposure pattern of electromagnetic energy for exposing at least part of the substrate.

19. The method of claim 18 wherein the material is chosen from the group comprising GaN, AlN, sapphire, diamond, SiO2, LiF, ZnS, and ZnSe.

20. The method of claim 18 wherein the substrate comprises a semiconductor wafer.

21. The method of claim 18 wherein said applied voltage or current changes the conductivity of said active region.